CLAIMS

1. A multi-mode antenna comprising:

a radiating conductor which radiates electromagnetic waves with a plurality of frequencies,

a first one-port resonant circuit connected to one end of the radiating conductor,

a second one-port resonant circuit connected to the other end of the radiating conductor, and

a single feeding point which is common for the plurality of frequencies and connected to the first one-port resonant circuit.

2. The multi-mode antenna according to claim 1,

wherein said first one-port resonant circuit is connected between one end of said radiating conductor and a ground potential point, said second one-port resonant circuit is connected between the other end of said radiating conductor and the ground potential point, and said feeding point is a connection point at which the first one-port resonant circuit and the one end of the radiation conductor are connected.

3. The multi-mode antenna according to claim 1,

wherein said first one-port resonant circuit is connected between one end of said radiating conductor and said feeding point, and said second one-port resonant circuit is connected between the other end of said radiating conductor and the ground

potential point.

4. The multi-mode antenna according to claim 1, further comprising a third one-port resonant circuit connected between one end of said radiating conductor and the ground potential point, wherein said first one-port resonant circuit is connected between one end of said radiating conductor and said feeding point, and said second one-port resonant circuit is connected between the other end of said radiating conductor and the ground potential point.

5. The multi-mode antenna according to claim 1,

wherein an imaginary part of admittance or impedance in view from said one end of said radiating conductor toward the radiating conductor has a value which alternates between positive and negative signs with frequency increase in said plurality of frequencies.

6. The multi-mode antenna according to claim 1,

wherein said radiating conductor is a single continuous body including ground potential.

7. The multi-mode antenna according to claim 1,

wherein said radiating conductor is spatially divided into parts which are electrically connected by a one-port resonant circuit.

8. The multi-mode antenna according to claim 1,

wherein the sum of the number of poles and the number of zeros in an equivalent circuit representation of the first

one-port resonant circuit connected to said one end of said radiating conductor is equal to the number of said plurality of frequencies.

9. The multi-mode antenna according to claim 4,

wherein the sum of the number of poles and the number of zeros in equivalent circuit representations of said first one-port resonant circuit and said third one-port resonant circuit connected to said one end of said radiating conductor is equal to the number of said plurality of frequencies.

10. A multi-mode antenna comprising:

a radiating conductor which radiates electromagnetic waves with a plurality of frequencies,

a first one-port resonant circuit connected to one end of the radiating conductor,

a second one-port resonant circuit connected to the other end of the radiating conductor,

a single feeding point which is common for the plurality of frequencies and connected to the first one-port resonant circuit, and

a multilayer structure of a laminate of a plurality of substrates comprising top, intermediate and bottom layers,

wherein a part of the radiating conductor is formed on the top layer, the first one-port resonant circuit and the second one-port resonant circuit are formed on the intermediate layer, the feeding point is formed on a side surface of the multilayer

structure, and a ground conductor having ground potential is formed on the bottom layer.

11. The multi-mode antenna according to claim 10,

wherein another intermediate layer is formed between said top layer and said intermediate layer and a shielding conductor to suppress electromagnetic coupling between said radiating conductor and said first one-port resonant circuit as well as said second one-port resonant circuit is formed on the another intermediate layer.

12. The multi-mode antenna according to claim 11,

wherein said shielding conductor is electrically connected to the ground potential.

13. The multi-mode antenna according to claim 10,

wherein said first one-port resonant circuit and said second one-port resonant circuit are formed as spiral conductors.

14. The multi-mode antenna according to claim 10,

wherein said first one-port resonant circuit and said second one-port resonant circuit are formed as meandering conductors.

15. The multi-mode antenna according to claim 10,

wherein said plurality of substrates are made of a radio frequency material selected from a group comprising dielectric substances and magnetic substances.

16. The multi-mode antenna according to claim 15,

wherein, when said plurality of insulating substrates are made of a dielectric substance, the plurality of substrates have different permittivity values each other and the permittivity of an upper-layer substrate is lower than that of a lower-layer substrate.

17. The multi-mode antenna according to claim 15,

wherein, when said plurality of insulating substrates are made of a magnetic substance, the plurality of substrates have different permeability values each other and the permeability of an upper-layer substrate is lower than that of a lower-layer substrate.

18. A method for fabricating a multi-mode antenna comprising a radiating conductor which radiates electromagnetic waves with a plurality of frequencies, a first one-port resonant circuit connected to one end of the radiating conductor, a second one-port resonant circuit connected to the other end of the radiating conductor, and a single feeding point which is common for the plurality of frequencies and connected to the first one-port resonant circuit, the method comprising the steps of:

forming a part of the radiating conductor on a top layer on the top surface of an upper substrate by film forming process;

forming the first one-port resonant circuit and the second one-port resonant circuit on an intermediate layer under the bottom surface of the upper substrate by film forming process;

forming a ground conductor with ground potential on a

bottom layer under the bottom surface of a lower substrate by film forming process;

forming a conductor including the feeding point on a side surface of the lower substrate by film forming process; and

bonding the bottom surface of the upper substrate and the top surface of the lower substrate to form a multilayer structure.

19. A RF module comprising:

a multi-mode antenna as recited in claim 1,

an RF multi-contact switch with as many contacts as the number of a plurality of frequencies, the RF multi-contact switch being connected to a single feeding point of the multi-mode antenna,

a plurality of circuit blocks respectively connected to the contacts of the RF multi-contact switch, and

a single-layer or multilayer RF substrate,

wherein the multi-mode antenna, the RF multi-contact switch, and the plurality of circuit blocks are mounted on the RF substrate,

wherein each of the plurality of circuit blocks comprises a duplexer, a power amplifier connected to one terminal of the duplexer, a transmit circuit connected to the power amplifier, a low noise amplifier connected to the other terminal of the duplexer, and a receive circuit connected to the low noise amplifier, and

wherein a plurality of common branch outputs of the duplexers corresponding to the plurality of circuit blocks are connected via the RF multi-contact switch to the single feeding point of the antenna.

20. A RF module comprising:

a multi-mode antenna as recited in claim 1,

an RF multi-contact switch with as many contacts as the number of a plurality of frequencies, the RF multi-contact switch being connected to a single feeding point of the multi-mode antenna,

a plurality of circuit blocks respectively connected to the contacts of the RF multi-contact switch, and

a single-layer or multilayer RF substrate,

wherein the multi-mode antenna, the RF multi-contact switch, and the plurality of circuit blocks are mounted on the RF substrate,

wherein each of the plurality of circuit blocks comprises an RF two-contact switch, a power amplifier connected to one terminal of the RF two-contact switch, a transmit circuit connected to the power amplifier, a low noise amplifier connected to the other terminal of the RF two-contact switch, and a receive circuit connected to the low noise amplifier, and

wherein a plurality of common branch outputs of the RF two-contact switches corresponding to the plurality of circuit blocks are connected via the RF multi-contact switch to the

single feeding point of the antenna.